MINERALS AND POWER

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THE importance of minerals in warfare is attracting the consideration of nations as never before. In time of peace the value of a nation's mineral deposits is easily underestimated. The higher the stage of development, the more essential become its mineral supplies. We have used the terms stone age, copper age, bronze age, iron age and coal age to designate different periods in the evolution of progress. Now, not only are we using far more coal per capita than ever before, but also vastly greater quantities of the materials that characterized former periods, namely, iron, copper and stone.

The development of the United States in industries, other than agriculture, is illustrated in the increased use of its mineral resources. Agricultural exports have increased greatly, but not in proportion to the mineral exports and the manufactured articles which have resulted from their utilization. In the period since 1880, foodstuffs (though showing an actual increase) have fallen from 55 per cent. to 21 per cent. of the total exports, while the export of manufactures has increased from 24 per cent. to 58 per cent. Exports of mineral products and manufactures thereof have increased from less than 4 per cent. in 1880, to 42 per cent. of the total exports in 1913 (the latest year unaffected by war conditions), an increase in value of more than one and one half billion dollars.

It is even more surprising if we compare the output per capita of the more important minerals for the last one third of a century. While the population has but doubled, the production and consumption of coal per capita has increased from less than 1½ tons to nearly 6 tons—an increase of 357 per cent. The United States took first rank in the production of coal in 1899 when Great Britain was surpassed and this lead has been maintained ever since. The production of iron ore increased 337 per cent.; petroleum 391 per cent.; copper 1,200 per cent.; cement 2,087 per cent.; gold, 23 per cent.; silver, 22 per cent.; lead, 125 per cent., and zinc 638 per cent. At the same time, the increase in agricultural products has but little more than kept pace with the growth of population, with the exception of cotton and sugar, which show advances of 130 per cent. and 394

per cent., respectively. Especially has the south increased its mineral production. In 1882 the Southern States produced but 8 per cent. of the mineral output of the United States; in 1890, 14 per cent.; in 1900, 16 per cent.; in 1910, 19 per cent.; and in 1914, 22 per cent.

The future of the mineral industry is assured, because of the increasing diversity of products and the known reserves of many minerals. In 1880 the statistics of mineral production in the United States covered about fifty articles, while the accompanying table shows over 75 items of considerable importance, and the report of the United States Geological Survey (1915) mentions about 90 additional products. Before 1880 the base metals and nonmetals were of subordinate importance, but now the former have come to the front and the latter have exceeded the total value of all the metals. The accompanying table shows that gold and silver have increased but a comparatively small percentage. Part of the output of these two metals, especially the silver, is from the by-products of copper and lead mines. Sulphuric acid, another by-product, has been in the past an embarrassment to operators of smelters, but is now a commodity of great price. Much of the platinum produced in this country is won from the refining of gold bullion and copper matte.

During this period of marked growth in mineral production, there has been a change in the character of the deposits worked —a passing from the exploitation of bonanzas to the working of low-grade deposits. This has led to the establishment of larger and more permanent communities and hence to a safer foundation for progress.

The relation of mining to other industries is obvious, and, for the last few decades, especially in western and northwestern America, the miner has been the pioneer of civilization. Since there has been such an enormous production from lean ores it follows that estimates of our reserves are constantly being raised. This increase in estimated reserves has also been brought about by further exploration. A few years ago it was estimated that the visible reserves of copper ore for four districts in three states was about 160,000,000 tons. Now these four districts are known to have 600,000,000 tons of reserve in spite of the fact that 60 million tons have already been mined. In like manner there has been an added estimate of phosphate rock and coal reserves. The field work done by the United States Geological Survey has increased the estimates of reserves of phosphate rock from a few hundred million tons to more than

five billion tons. The quantity of easily accessible anthracite and bituminous coal exceeds the estimated tonnage in 1909 by 440 billion tons, an increase of nearly 30 per cent., and the day of opportunity for both exploration and investigation of the mineral resources of this country is not by any means past.

The accompanying table shows the enormous growth of mineral production in the United States in the last thirty-seven years. Some of the statistics are a little misleading, as is always the case where values are given instead of amounts. Prices change from time to time and often enormously. Amounts for the earlier years are hard to obtain, and it was thought best to keep the values as a basis for comparison throughout. It can be seen that most of the outputs have increased much more rapidly relatively than the population. In some cases there has been a steady growth in the utilization of some particular product; in others there are sudden rises due to new discoveries or inventions or to abnormal conditions in trade or manufacture, for example, the exigencies brought about by the present war. The effect of the war is easily seen if we consider our exports since 1914. The exports of the articles considered in the accompanying table show an increase of about 300 per cent., or from $515,000,000 in 1914 to $2,043,000,000, in 1917. The value of the exports of coal and coke rose from $62,700,000 in 1914 to $89,400,000 in 1917; copper and copper manufactures from $149,400,000 to $323,900,000; iron and steel, including manufactures but excluding machinery, from $135,800,000 to $867,100,000; lead and lead manufactures, from $3,100,000 to $16,500,000; zinc and zinc manufactures, from $1,000,000 to $67,100,000; brass and brass manufactures, from $7,400,000 to $383,200,000; cartridges from $3,500,000 to $65,100,000, and petroleum, from $152,100,000 to $230,900,000.

With the anomalous conditions brought about by the war there has been a great development of many of the rare minerals. Many others, formerly of but little industrial value, have been used for substitutes for those which are practically indispensable. Whenever other factors do not interfere the industries of any nation are generally more stable when it contains within its borders the basic raw materials for the maintainance of its industries, but with the great diversity of modern manufactures many nations demand a variety of substances all of which are rarely available on one continent. The cheap water transportation between continents permits the competition of foreign and domestic resources. This is especially true if there is no tariff. The tendency has been, therefore, for the

richest deposits to supply the markets of the world. This condition has been changed by the location of many resources with respect to warring countries and by the great scarcity of ships, hence, the development of the substitutes and rare minerals of the United States.

Titanium, which had declined in use because of the open-hearth method of making steel, having supplanted the Bessemer process, is again in demand as a substitute for manganese in some processes, and also for aluminum in deoxidizing steel.

Much manganese dioxide was used before the war in neutralizing the greenish color of untreated glass. Much of this had come from the Turkish empire, and the available ore from other sources furnished the material at too high a price. It was found that selenium, which had been but little more than a curiosity, could be substituted. As a result there were about 50,000 to 60,000 pounds of selenium used in 1917. Selenium is a by-product of copper refining, and made only in the United States. Its success in connection with glass seems to assure its permanent use in the future.

Uranium and vanadium have also been used much more extensively since the war began; the former in ferro-alloys in connection with tungsten to reduce the quantity of the tungsten and the latter in ferro-alloys which have great shock-resisting qualities, as for heavy frameworks for locomotives.

Molybdenum is in great demand, having doubled in the world's production in the last two years. It has many important uses where resiliency and shock-resisting steel is needed. One of the important uses at present is in the lining of cannon and gun barrels which greatly lengthens the usefulness of each.

Cadmium is a mineral whose output was hardly worthy of mention in 1913; in 1916 there were produced 135,212 pounds, valued at $205,433. Before the war the chief output came from Silesia and hence was shut off from world trade. Some has been recovered in various processes in which zinc compounds are involved. It is used as a pigment and at present is important in some secret war use.

Chromium gives hardness to an alloy and prevents rust, consequently there has been a great demand for chrome steel for war purposes. Hence a great increase in production of cromic iron ore has been brought about since 1914. Another important use of chromium is in the tanning of chrome leather. In 1913 the United States produced 255 long tons, valued at $2,854; in 1916, 47,035 long tons valued at $726,243; and in 1917 there was a slight increase over the latter figure. The prin-

cipal sources of production were Rhodesia and New Caledonia, with lesser amounts from Russia and India.

Prior to the war, from 90 per cent. to 95 per cent. of the world's platinum came from Russia. The only other important source was Colombia. The normal world's production is about 250,000 troy ounces. In 1913 the United States produced 1,034 troy ounces of platinum (and allied metals), valued at $46,530; in 1916, 28,088 troy ounces, valued at $2,301.762. It is used in jewelry, chemistry, dentistry and electrical contact points. Paladium may be substituted for platinum in dentistry where great strength is not needed. At present there is a strong demand for platinum for use in the manufacture of sulphuric acid.

Because of the enhanced price quicksilver has increased in production very rapidly in the last few years. The chief producers are Spain, Italy, Austria-Hungary and the United States. In 1913 the United States produced 20,213 flasks (75 pounds net), valued at $813,171; in 1916, 29,932 flasks, valued at $2,576,547; in 1917, 36,351 flasks, valued at $3.857,000. It is used mainly in the manufacture of fulminate for explosive caps, of drugs, of paint, of electrical appliances, and scientific apparatus, and in the recovery of precious metals by amalgamation. The first use mentioned above caused the great demand and high price, with consequent increased production.

Ten years ago, tungsten was only of moderate use in the steel industry. Now the world's production is about 10,000 tons and the United States is the largest producer of tungsten ore in the world. Before the war, Germany controlled the output from ore supplies, largely from British possessions, but it is manifestly the intention of England to control most of the minerals of the Empire in the future. Tungsten is the most important of the metals used in high-speed steel. About 90 per cent. of the tungsten output is used in alloys, mostly in steel.

In the case of manganese ore which has become so necessary to modern industries and which for a period of years was supplied by many deposits in several countries, there has been a steady decline in the production from minor deposits relatively near markets and a corresponding increase in production from a few rich, even though remote, deposits. None of the industrially important nations produce more than a very small part of the manganese ore that they need; all of them have procured most of this in normal times from the three important sources in the world—Russia, India and Brazil. Manganese and manganiferous ores (the two chief sources of manganese) were produced in the United States in 1913 to the amount of 4,048 and

NON-METALS

	1880	1900	1913	1916	1917
Arsenious oxide	.....	.....	159,000	555,000	1,300,000
Asbestos	4,312	16,000	11,000	448,000	
Asphalt	4,400	416,000	5,282,000	7,102,000	
Barytes (crude)	80,000	188,000	156,000	1,011,000	
Borax (crude)	277,000	1,018,000	1,492,000	2,409,000	
Bromine	115,000	141,000	115,000	922,000	
Calcium chloride	.....	.....	130,000	217,000	
Cement	1,853,000	13,284,000	89,551,000	104,689,000	Slight increase
Clay	200,000 (potter's)				
Products	.....	96,212,000	181,289,000	207,260,000	
Raw	.....	1,840,000	4,180,000	5,752,000	
Coal					
Bituminous	53,444,000	220,930,000	565,235,000	665,116,000	Increase, 8.3 per cent.
Pennsylvania anthracite	42,197,000	85,758,000	195,181,000	202,010,000	Increase, about 20 per cent.
Cobalt oxide	24,000	12,000	.....	.....	
Coke	6,631,000	47,443,000	128,922,000	170,841,000	
Diatomaceous or infusorial earth and tripoli	45,600	24,000	286,000	242,000	
Emery	29,000	103,000	4,800	124,000	
Feldspar	60,000	181,000	777,000	702,000	
Fluorspar	16,000	95,000	736,000	923,000	
Fuller's earth	.....	68,000	370,000	707,000	
Garnet (abrasive purposes)	.....	123,000	183,000	209,000	
Gems and precious stones	100,000	233,000	319,000	218,000	
Graphite	50,000	.....	.....		
Amorphous	.....	198,000	39,000	21,000	
Crystalline	.....		254,000	915,000	Increase, 24 per cent.
Grindstone and pulpstone	500,000	710,000	856,000	766,000	
Gypsum	400,000	1,627,000	6,775,000	7,959,000	
Lime	19,000,000	6,797,000	14,648,000	18,619,000	Decrease, 10 per cent.
Magnesite (crude)	.....	19,000	77,000	1,394,000	Increase, 100 per cent.
Marls	500,000	30,000	.....	.....	
Mica					
Scrap	.....	55,000	83,000	70,000	
Sheet	128,000	93,000	354,000	524,000	
Millstones	200,000	33,000	56,000	45,000	
Mineral paint					
Natural pigments	146,000	644,000	512,000	Value given under unspecified	
Zinc and lead pigments	764,000	3,667,000	9,021,000	23,516,000	24,614,000
Mineral waters	500,000	6,245,000	5,631,000	5,735,000	
Natural gas	.....	23,699,000	87,847,000	120,227,000	
Oilstones	8,000	174.000	207,000	155,000	
Peat	.....	.....	197,000	369,000	
Petroleum	24,601,000	75,989,000	237,121,000	330,900,000	Increase, 14 per cent.
Phosphate rock	1,124,000	5,359,000	11,796,000	5,897,000	
Potash	.....	.....	.....	4,243,000	
Pumice	.....	.....	55,000	82,000	
Pyrite	5,000	750,000	1,286,000	1,966,000	
Salt	4,830,000	6,945,000	10,123,000	13,646,000	Increase, 9 per cent.

NON-METALS

	1880	1900	1913	1916	1917
Sand Glass	.....	.....	1,896,000	1,958,000	
Molding, building and gravel	.....	.....	22,322,000	27,852,000	
Sand, lime brick	.....	.....	1,238,000	1,474,000	
Silica (quartz)	80,000	127,000	201,000	243,000	
Slate	1,530,000	4,240,000	6,175,000	5,339,000	
Stone	20,626,000	36,971,000	83,733,000	79,042,000	
Sulphur	21,000	88,000	5,480,000	Under unspecified	
Sulphuric acid	.....	.....	4,346,000	14,100,000	Increase, over 50 per cent.
Talc and soap stone	67,000	384,000	1,120,000	1,292,000	
Talc (fibrous)	55,000	500,000	789,000	962,000	
Thorium minerals (monazite)	.....	49,000	.....	3,400	
Zircon	.....	49,000	.....	.....	
Unspecified	6,000,000	1.000,000	420,000	15,000,000	

Figures for the year 1917 must be regarded as approximate, rather than final. "Increase" or "decrease" applies to amount, not values.

METALS

	1880	1900	1913	1916	1917
Aluminum (consumption)	.....	$1,920,000	$13,845,000	$33,900,000	
Antimonial lead	240,000	995,000	1,592,000	4,464,000	
Antimony	10,000	838,000	429,000	Figures not available	
Bauxite	.....	90,000	998,000	2,296,000	
Cadmium	.....	.....	.....	205,000	
Chromic iron ore	28,000	1,400	2,854	726,000	Slight increase
Copper (value at New York city)	12,943,000	100,615,000	189,795,000	474,288,000	510,000,000
Ferro-alloys	.....	.....	13,015,000	50,282,000	
Gold	36,000,000	79,171,000	88,884,000	92,590,000	84,457,000
Iron ore	23,157,000	66,590,000	130,906,000	181,902,000	236,178,000
Pig iron	89,316,000	259,944,000	458,342,000	663,478,000	Slight decrease
Lead (refined value at New York city)[1]	9,573,000	22,961,000	36,245,000	76,207,000	78,816,000
Manganese ore	86,000	100,000	40,000	627,000	Increase 300%
Manganiferous ore	Included under iron ore		25,000	2,005,000	
Nickel (value at New York city)	257,000	3,886	79,000	671,000	Decrease, about 20 %
Platinum	400	2,500	47,000	2,302,000	
Quicksilver (value at San Francisco)	1,858,000	1,273,000	813,000	2,577,000	3,857,000
Silver	34,717,000	35,741,000	40,348,000	48,953,000	About same
Tin (metallic equivalent)	.....	.....	47,000	no figures	
Titanium ore (rutile)	400	1,300	49,000	no figures	
Tungsten ore (60 per cent. concentrate)	.....	11,000	672,000	.....	Increase 800T (16%)
Uranium and vanadium minerals	.....	.....	609,000	no figures	
Zinc, sales values	2,833,000	10,902,000	37,772,000	151,005,000	102,350,000

59,403 long tons, respectively, and valued at $40,080 and $25,-124; in 1916, 26,997 and 548,803 long tons, valued at $627,417 and $2,005,491. In 1917 there was an increase over the 1916 production of manganese ore of about 300 per cent. The use of ferromanganese and spiegeleisen in manganese steel is a well established industry. Manganese is used to remove oxygen and sulphur from steel and thus render it very hard, but still ductile, therefore, such steel is used for a number of purposes requiring a hard, tough steel. Manganese ore is also used in dry batteries and in the flint-glass industry.

Magnesite has increased in production many fold. It is used for refractory bricks in open-hearth furnaces, composition flooring, fire-resistant paint, sulphite process in wood pulp manufacture, heat insulators or covering for steam pipes, and in magnesia cement. Magnesia cement is used for making decks of ships, floors of hospitals and railroad cars, and has been employed successfully in the European war for making gun emplacements, as it sets quickly and has some resilience.

There are many other substances that have increased abnormally in the last three years. Of these may be named, asbestos, barytes, potash, sulphur, iron pyrite and sulphuric acid.

In a report to the President a few years ago, the Secretary of the Interior, in speaking of the resources of the country, gave minerals a high rank and referred to them as "The Foundations of Power." "A nation that produces under normal conditions 40 per cent. of the world's coal and 66 per cent. of its petroleum surely has its share of the two great fuels; add the fact that our mines, furnaces and smelters yield 40 per cent. of the world's iron, 60 per cent. of its copper, and 32 per cent. of its lead and zinc, and the reason is patent for America's industrial greatness."[1]

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